Abdominal Muscles Support and Regulate Digestion

Abstract—This paper explores the role of abdominal muscles in regulating human digestion, with a particular focus on the pathophysiology of gastrointestinal disorders, especially irritable bowel syndrome (IBS). We propose a hypothesis emphasizing the functional contribution of abdominal muscles in controlling food transit through the gastrointestinal tract, primarily through the regulation of intra-abdominal pressure. Our model suggests that abdominal muscles, rather than the intestine itself, are critical in modulating gastrointestinal motility and pressure dynamics. This theory provides new insights into common gastrointestinal symptoms, including heartburn, hemorrhoids, IBS, and lactose intolerance, by suggesting that abdominal muscle activity plays a central role in digestive health.

Keywords—Heartburn, Hemorrhoids, Irritable Bowel Syndrome (IBS), Abdominal Muscles, Intra-abdominal Pressure, Intestinal Motility

Ethics Declarations—This manuscript does not present a clinical trial and does not involve any patient data or identifiable personal information. It does not include case reports, nor does the study involve human or animal subjects.

Conflicts of Interest—The author declares no conflicts of interest. This study did not receive any external funding.

I. INTRODUCTION

The gastrointestinal (GI) system is traditionally regarded as highly complex and autonomous, with the intestine considered the primary organ responsible for digestion [1, 2]. However, the conventional model, which treats the intestine as a discrete entity performing digestive functions, overlooks the significant role of the abdominal muscles in regulating the digestive process. In this paper, we argue that digestion is not a continuous, linear process, as traditionally depicted, but rather a series of distinct, coordinated phases influenced heavily by abdominal muscle activity. In this revised framework, abdominal muscles are not merely passive structures but active regulators of gastrointestinal motility. They modulate pressure dynamics within the abdominal cavity, thereby affecting food movement through the gastrointestinal tract. In contrast, the intestine plays a more passive role, primarily involved in nutrient and water absorption, rather than the mechanical movement of contents. This hypothesis posits that abdominal muscle activity is central to controlling the flow of digested material by regulating intra-abdominal pressure, which is crucial for efficient digestion. We also hypothesize that patients with irritable bowel syndrome (IBS) may influence gastrointestinal dynamics not only through altered muscle function but also through behavioral factors such as posture. This may either be a direct response to internal factors like inflammation or a compensatory mechanism to alleviate symptoms like heartburn. The role of posture in gastrointestinal health has been underappreciated, yet we suggest that simple changes in posture may significantly influence gastrointestinal motility and symptomatology.

A few previous studies have explored the relationship between posture, abdominal muscle function, and gastrointestinal motility. It has been suggested that the abdominal wall provides critical support to the gastrointestinal organs [3]. Interestingly, a new hypothesis regarding IBS attempts to link its symptoms to the effects of gravity [4], proposing that gravitational forces may exacerbate symptoms by altering the pressure dynamics within the abdominal cavity. Postural adjustments have also been shown to influence gas dynamics, which may impact digestive function, particularly with regard to bloating, reflux, and other symptoms commonly experienced by individuals with functional GI disorders [5, 6]. On the other hand, some research suggests that abdominal distension may be a consequence rather than the cause of functional GI disorders, including IBS [7]. A study comparing muscle activity in healthy individuals and IBS patients during various postural and abdominal movements found no significant differences between the two groups [8]. Nevertheless, we hypothesize that IBS patients may still influence gastrointestinal dynamics through subtle behavioral adjustments, such as changes in posture, which could alter intra-abdominal pressure and affect motility. These adjustments may result from factors like internal inflammation or discomfort commonly associated with IBS, heartburn, or other functional GI disorders. Furthermore, changes in posture can lead to permanent muscle displacement, which may be diagnosed as Diastasis Recti [9].

II. PROPOSED DIGESTIVE FUNCTION

Abdominal muscles play a central role in regulating intra-abdominal pressure, a key factor in controlling gastrointestinal motility. Abdominal muscle pressure (AMP) modulates the transit of food through the gastrointestinal tract by exerting pressure on the intestines and coordinating the timing of food release at various stages of digestion. Feedback from sensory receptors in the gastrointestinal tract provides real-time information, allowing precise regulation of AMP (Figure 1).

- **Stage A (Chewing and Gastric Mixing):** The first stage of digestion involves mastication and gastric mixing with gastric acid and digestive enzymes, where the stomach processes food into a chyme-like mixture. During this stage, AMP helps maintain food in the stomach, preventing premature gastric emptying. A brief relaxation of the abdominal muscles (BR) allows for controlled release of chyme into the small intestine when ready for the next phase.
- **Stage B (Dissolution and Absorption in the Small Intestine):** Here, gastric acid and digestive enzymes are neutralized and absorbed across the small intestine. AMP is critical, as it spreads the chyme thinly over the intestinal wall, optimizing absorption and enabling gas expulsion from the gastrointestinal tract. This phase typically lasts a significant amount of time, with food remaining relatively stationary. A brief relaxation (BR) of the abdominal muscles allows controlled progression of chyme into subsequent stages.
- **Stage C (Nutrient Absorption):** This phase focuses on nutrient absorption and water reabsorption. AMP plays an essential role in maintaining food immobility during this phase, ensuring optimal spread and nutrient absorption. A brief relaxation (BR) signals the transition to the final stage.

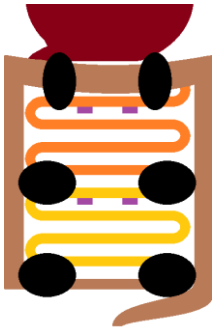

Figure 1: Proper digestive function. Red: Stage A, Orange: Stage B, Yellow: Stage C, Brown: Stage D, Black: Abdominal muscles regulate the flow, Purple: Level, hunger, and AE sensors

- **Stage D (Dehydration and Fecal Formation):** The final stage involves the dehydration of indigestible material, with AMP facilitating the compaction of stool. This process helps form solid stool in the large intestine. AMP is again essential here.

In all stages, AMP helps coordinate the movement of food through the gut, ensuring proper motility and facilitating transitions between phases based on real-time feedback from intestinal mechanoreceptors and chemoreceptors. These feedback loops allow abdominal muscles to exert fine control over the digestive process, preventing premature or delayed food transit.

III. POSTURE-HINDERED DIGESTION (PHD)

Posture-Hindered Digestion (PHD) is gastrointestinal dysfunction, resulting from long-term poor posture, which leads to a gradual loss of effective abdominal muscle function. Over time, improper posture causes progressive changes in body mechanics, reducing AMP and impairing normal digestive function (Figure 2).

Figure 2: Stage B under: A) Normal AMP, B) Reduced AMP, C) No AMP

- **Early Symptoms:** Reduced AMP causes an increase in intestinal diameter, impairing food spreading and digestion. Patients may experience early satiety, larger stool size (initially diagnosed as constipation), and heartburn due to the reduced ability to separate acid from food. Additionally, inefficient gas expulsion contributes to bloating.
- **Moderate Symptoms:** As intestinal diameter increases, the small intestine becomes less capable of fully reabsorbing gastric acid and food ingredients. This leads to the leakage of partially digested food into the colon, resulting in symptoms such as hemorrhoids, excessive gas (both upward and downward), and diarrhea. These issues may be diet-related, and the implementation of low FODMAP or lactose-free diets can help alleviate symptoms.
- **Late Symptoms:** As posture deteriorates, the failure of abdominal muscle-controlled flow valves leads to faster food transit through the gastrointestinal tract. This results in abdominal pain, frequent loose stools, excess gas, and chronic diarrhea. Additional symptoms may include bladder habit changes and hernias due to the loss of abdominal muscle support. Musculoskeletal issues, including back pain and spinal deformities, may also arise.

IV. DISCUSSION

- **AMP and Gastrointestinal Motility:** Decreased AMP leads to a loss of proper motility in the gastrointestinal tract, resulting in larger intestinal diameters and poor contact between food and the intestinal wall. This impairs nutrient absorption and can cause symptoms such as heartburn and bloating. Over time, this can contribute to faster food transit, with patients experiencing symptoms typical of IBS, including diarrhea, abdominal pain, and altered bowel movements.
- **Dietary Factors and Their Impact on Motility:** Foods high in FODMAPs or containing alcohol and caffeine can exacerbate digestive dysfunction. These foods either alter gastric acid secretion or delay digestion, resulting in malabsorption or fermentation in the colon. This may contribute to bloating, heartburn, and other functional GI disorders [10].
- **Impact of Medications and Stress:** Certain medications might increase AMP, leading to constipation [11], while anxiety-related stress can enhance AMP, which may be perceived as a protective mechanism during stressful events. Stress and postural changes are often linked to gastrointestinal disturbances, influencing motility and exacerbating conditions like IBS.

V. THEORETICAL AND EXPERIMENTAL EVIDENCE

- **Physics:** Abdominal pressure is generated and controlled by the abdominal muscles. It is uniformly applied across the exterior of the intestinal wall, due to the presence of abdominal fluids. This uniform pressure force (N) is directly applied to all intestinal contents, controlling friction and thus their speed, according to the friction law $F = \mu N$, where F is friction and μ is the coefficient of friction, an empirical property of contacting materials [12]. Bread has a higher μ than milk or butter, which provides a purely mechanical perspective on food effects and symptoms. Further, periodic AMP micro-oscillations may separate the meal into portions with different μ, as liquids and gases will backpropagate more easily (Figure 3).

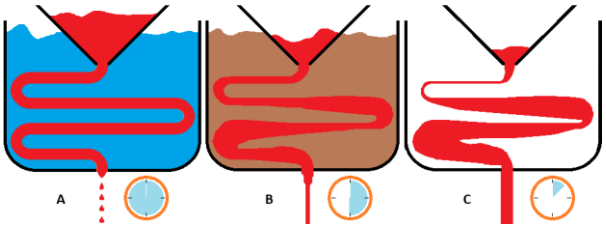

Figure 3: A) Water, high AMP, B) Oil, medium AMP, C) Empty, no AMP

- **In Vitro:** A simple experimental setup with a bucket (abdomen), flexible nylon tube (intestine), funnel (stomach), water or oil (abdominal fluid pressure), and tomato juice (food) can demonstrate the effects of AMP. When the bucket is filled with water or oil, different densities of liquids create varying AMP levels, influencing food transit.

VI. CONCLUSIONS

Abdominal muscles are critical in maintaining intra-abdominal pressure, necessary for regulating gastrointestinal motility and ensuring efficient digestion. While the intestinal wall plays a role in nutrient absorption, only the abdominal muscles can maintain the required pressure for optimal digestion. Understanding abdominal muscle function and its impact on gastrointestinal dynamics is essential for developing effective treatment strategies for disorders like IBS and other functional gastrointestinal diseases.

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